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THE VETERINARY JOURNAL

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The Veterinary Journal

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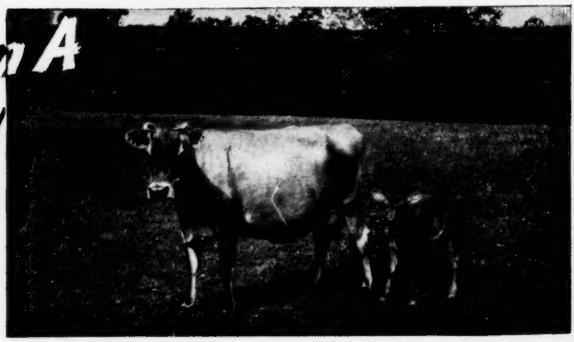

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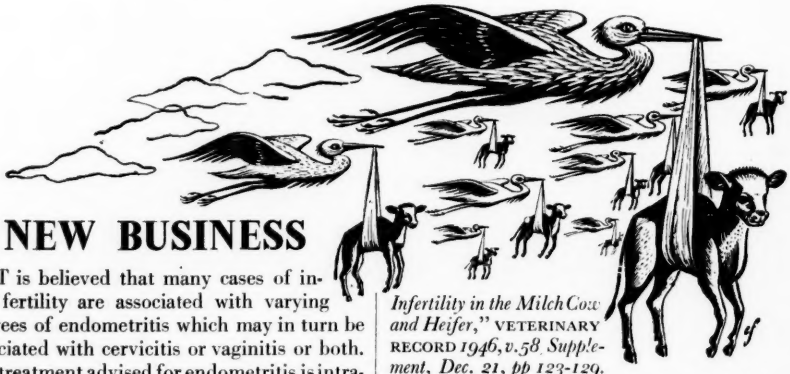

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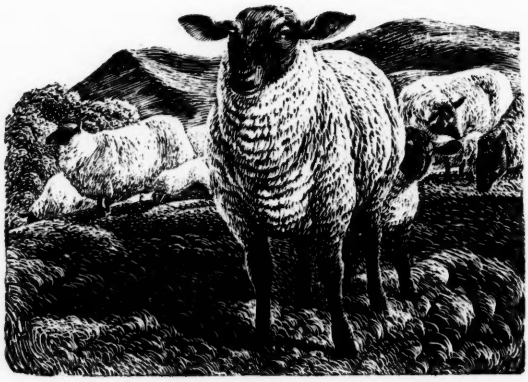

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Vol. 103 November, 1947 No. 11

EDITORIAL

SHOULD THERE BE A WARNING?

To become a veterinary surgeon was always an attractive prospect to ambitious youth. At the present time there are indications that this prospect appears to be more alluring than ever.

The teaching institutions are full almost to bursting point. All the colleges have long waiting lists and many prospective students are frustrated when they find that their chances of gaining a place may be subject to delay sometimes as long as five years. If one studied the ebb and flow of undergraduates over a period of years and made a graph of these years, one would find that, as is the case in any other calling, the line of the curve would register high points and low points in more or less alternate sequence.

The ruling factor governing the curve would be found to be the law of supply and demand.

Now since about the year 1930 the numbers of students have increased steadily and of late that increase has gained much in momentum.

At its inception there was a simple explanation for the increase, for it followed as a natural consequence the paucity of the 1920's.

The years immediately following the first world war were years of depression for veterinary surgeons. This depression made its mark on the colleges. One college was in grave danger of closing down and there were competent men who were of the opinion that one college could supply all the needs of the British Isles and also provide a sufficient number to man posts abroad. During these years of depression many rural areas which had previously supported a professional man became almost sterile and the great town practices went into a decline. Those who had fain to work as assistants found that their recompense was less than that of a corporation roadman. Many extremely eligible candidates were thereby discouraged from entering upon the period of study and the toll of death exceeded the numbers of recruits. As a consequence the number of practising veterinary surgeons diminished greatly.

In some ways this had a salutary effect, for owing to lack of competition the prospects of those remaining were considerably enhanced.

Veterinary surgeons, and particularly practitioners, again became prosperous men and their prosperity was noised abroad. So an increasing number of students

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were attracted to the colleges in the sure hope that they would reap an adequate reward when they graduated. Now this increase appears to show no sign of abatement and at the present time the number of undergraduates and the number of graduates are greater than ever. The 1930's were years of shortage and graduates were absorbed easily. Just previous to the recent war there were signs that an absorbable limit had been reached. In the first two years of the war there was a definite surplus and many graduates were unemployed and perforce had to seek work in other spheres. Then came the call from the Forces, owing to the opening up of the eastern campaigns. We were again faced with a grave shortage for civilian needs, for the same reasons that there were shortages of doctors, plumbers, carpenters, etc. Now that the war is over, the number of applicants for places in the colleges does not let up, indeed it has grown to a mighty flood.

There are many within the profession who view this with misgiving, but there are others who would attract more and more to the fold.

The situation must be clarified. Are all these potential veterinary surgeons assured of a living commensurate with the years of study and expense involved in their training, a living appropriate to the status of a professional man or woman? The doubters say that this is not so, for many avenues of employment previously available are now closed or restricted for a variety of reasons. They instance India, Burma, Egypt, Palestine, Irak, Canada, Australia, New Zealand, South Africa and South America. The needs of the Army are few and appointments in commercial and municipal service sadly reduced. When it is pointed out that the Ministry of Agriculture propose to employ many more, they reply: "If that is so, surely these men will have to justify their existence, and if they do so then there will be less work for the private individual."

The optimists discount these arguments and say that the profession can absorb twice the present number of graduates. What gives rise to their optimism, which we all hope will prove to be correct? Logically, this optimism means that in every place where one man gets a living there shall be two in the future. Is this a true estimate, can it be implemented without lowering the standard of life? Now, these questions are vital and they must be answered not only for the sake of those already in the profession but more especially on behalf of all those who would essay to become the veterinary surgeons of the future.

We must remember that "It is the state of the market which rules the price." It is immaterial whether the product on offer be a material thing such as a motor car or a bullock, or human manpower. It would be good if such a body as the R.C.V.S. could consider this matter in all its aspects and make an authoritative statement. All may be well, but there are many who view the prospects with apprehension.

GENERAL ARTICLES

SOME CASES OF PURPURA HÆMORRHAGICA IN THE HORSE

By A. R. JENNINGS and D. R. HIGHET
Liverpool

Introduction

PURPURA HÆMORRHAGICA has been defined as "a disorder of the blood characterised by hæmorrhages into the skin and mucous membranes, the internal organs and other tissues" (Wintrobe [1946]). This definition applies particularly to the human subject. Hutyra and Marek (1938) defined purpura as "an acute non-contagious disease of horses probably arising from septic bacterial intoxication and characterised by extensive swellings of the subcutaneous tissues, with hæmorrhages into these and also into the mucous membranes and the internal organs."

This type of syndrome is met with in man, horses, dogs, cattle and goats, but relatively little is known about its ætiology. It appears doubtful if the condition is the same in every species of animal and if the same ætiology applies.

In the human subject the purpuras have been divided into two main groups, the thrombocytopænic and the non-thrombocytopænic types. The two are distinguished by blood examinations. These main groups are again subdivided on ætiological grounds. This is not very satisfactory since the ætiology is, as yet, not very well defined. Even the basic distinction of the two types is by no means absolute since it has been shown that the hæmorrhage is not always related to the degree of platelet reduction.

In the horse no such classification has been made. The disease is, generally speaking, seen as a sequel to some other disease, usually of a suppurative nature, or one in which there has been some degree of necrosis. Purpura hæmorrhagica is a frequent sequel to such conditions as strangles, pneumonia, pharyngitis, empyæma, etc. In the human subject a somewhat similar clinical history is noted in that the disease may arise in the course of some acute bacterial disease. In the absence of platelet reduction the disease is classified as a symptomatic non-thrombocytopænic purpura. This type of disease in man is also characterised by effusion of serum into the tissues, particularly the subcutaneous and submucous tissues.

This characteristic œdematous infiltration of the tissues together with the hæmorrhages indicates that one of the primary causes must be some defect of the capillary walls. Davidson (1939), speaking generally of the ætiology of purpura, was of the opinion that "damage to the capillary endothelium appeared to be the primary cause of the bleeding." This damage to the endothelium is of importance even in the case of thrombocytopænic purpura in man (Wintrobe). Factors which Davidson thought were of importance included the intensity and duration of the infection, the variability of the reaction of the tissues in different individuals, the presence of anæmia with consequent hydræmia and reduced nutrition of the vascular endothelium and the bone marrow, together with capillary and arterial hypertension and degeneration. Earlier work on purpura

(Krocher, cited by Hutyra and Marek, 1938) suggested that vitamin C was of importance in capillary nutrition, and this was confirmed by the extensive work done on scurvy. Hughes, D. L. (1939), in a brief survey on capillary nutrition, suggested that purpuras might be due to defective capillary nutrition and he was of the opinion that vitamin P might be of value in the treatment of the conditions. Hutyra and Marek (1938) cited Dieckerhof, who assumed that a toxin was produced by the micro-organism responsible for the primary disease and that this was responsible for the changes in the vascular endothelium which, in turn, were responsible for the signs and symptoms of purpura.

The pathogenic organism most frequently associated with purpura hæmorrhagica in the horse is the streptococcus. It is not surprising, therefore, to find that many attempts have been made (Hutyra and Marek, 1938) to reproduce the disease by the inoculation of streptococcal cultures and extracts of streptococci. These attempts met with little success. Goodner, E. K., *et al.* (1937), however, were able to produce purpura in laboratory animals by the inoculation of extracts of pneumococci. Streptococcal antiserum was said to be of value in the treatment of purpura in horses (Taubitz, 1936).

The suggestion has been made on many occasions that purpura in the horse is of anaphylactic origin. Grieg (1938) regarded the condition as allied to the anaphylactoid purpuras of man, which implied that it would be classified as a primary non-thrombocytopænic purpura and would fall into the same group as the purpuras of Henloch and Schonlein. The experiments of Marek with streptococcal extracts and those of Ritzenthaler (cited by Hutyra and Marek, 1938) lend some support to this view. Davies, G. O. (1946) put forward the view that purpura was in the nature of an histaminosis and the reaction was of an anaphylactoid nature. He suggested that the histamine liberated exerted a direct action on the integrity of the vascular endothelium. Kramer (1929) described a typical case of purpura which developed after a second injection of tetanus antitoxin. He regarded this as being of anaphylactic origin.

There are few records of blood examinations in the domesticated animals affected with purpura hæmorrhagica. Hutyra and Marek (1938) stated that the blood picture was not characteristic. They stated that hæmolysis, diminution of the platelets and increased rate of precipitation of the corpuscles occurred. Hypoleucocytosis was said to be indicative of a grave outcome. Witman and Contis (1924), cited by Udall (1939), described the blood changes in equine purpura as "a progressive anæmia, the red cells may sink as low as three millions per cu. mm., with a corresponding drop in the hæmoglobin." At the outset the leucocytes increase, the lymphocytes diminish in number and the eosinophils may disappear. Later, regenerative changes may be noted. The blood platelets are said to be destroyed.

Bellocq *et al.* (1943) described some blood changes in a horse affected with chronic purpura, said to be of hepatic origin. Their findings may be briefly summarised as:

Red cell count, 12 millions per cu. mm.
Hæmoglobin (Tallqvuist), 90 per cent.
Colour index, 0.49.
Coagulation time, 1 to 1½ hours.

They noted that the blood serum in this animal was deeply pigmented and they ascribed this to the presence of large amounts of bilirubin. The erythrocytes were said to be markedly fragile. In a second case very similar to the one described they noted a decrease in the number of platelets.

The cases of purpura hæmorrhagica described in this paper were encountered during an outbreak of laryngo-tracheitis which occurred amongst heavy draught horses in the early part of 1947. Eight cases were seen during this outbreak and these, together with two cases following a strangles outbreak at a later date, form the basis of this paper. Particular attention was paid to the blood changes. Before describing the hæmatology, a brief description of the clinical features of the primary disease, laryngo-tracheitis, would not be out of place.

Horses of any age appeared to be susceptible. The disease spread extremely rapidly and in individual stables the morbidity varied from 10 to 100 per cent. In all, some 500 horses were affected. Animals in poor condition were more severely affected. The most characteristic symptom was the cough which was invariably present. It was short and dry and easily induced by pressure on the larynx and trachea. In a few cases the cough was drawn out and obviously painful, the animal standing with head extended and showing considerable distress. The temperatures of affected horses varied, usually fluctuating between 101° F. and 103° F. for two or three days and then gradually subsiding. Some cases had an initial temperature of 106° F.

An inconstant symptom was a nasal discharge which at first was thin and watery, later becoming mucopurulent. In typical cases the disease ran its course in ten to fourteen days. The main complications were:

Purpura hæmorrhagica, eleven cases, of which eight are recorded.

Pneumonia, five cases.

Strangles, isolated cases.

Meningitis, one case.

Treatment was symptomatic and simple hygienic measures gave excellent results. The pneumonia and strangles cases were treated with sulphanilamide *per os*. No deaths occurred in the uncomplicated cases, so that a description of the lesions cannot be given, but it is significant that in one case in which tracheotomy was performed the trachea was very œdematous and highly coloured.

The clinical features of purpura hæmorrhagica in the horse are too well known to be reiterated here, but a striking feature was the rapidity with which the symptoms appeared. There did not appear to be any factor in the development of purpura from the primary disease which was constant in all cases.

Blood Examinations

Blood was withdrawn from the jugular vein into two tubes. One specimen was allowed to clot and the other was citrated. Samples were taken every 48 hours and, as a routine, the following examinations were carried out: red cell and white cell counts, platelet and differential leucocyte counts, hæmoglobin estimations and packed cell volume. The technique of these examinations was

according to the methods described by Wintrobe (1946). The icteric index was determined by a colorimetric method described by Kolmer and Boerner (1941). This was a purely arbitrary method.

Case No. 1.—This case, a Bay Cart Mare aged 10 years, was a typical one and the history and hæmatological findings were as follows:

4/3/47.—Cough and nasal discharge, gradual apparent recovery until 13/3/47, when the animal showed severe respiratory distress and pyrexia (temperature 104° F.). Both hind limbs were stiff and swollen from the stifle downwards, the swellings were clearly demarcated from the healthy tissue. There was a slight bilateral hæmorrhagic nasal discharge and the nasal mucous membrane showed numerous petechiæ and ecchymoses.

Calcium lactate was given intravenously for three successive days and then every other day. Meanwhile œdematous areas had appeared between the fore legs and around the nostrils. Appetite was in abeyance for the first three days but then it gradually returned. On 20/3/47 there was little sign of the disease except for some thickening of the hind limbs.

Date	R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
13/3/47	5.6	16.0	12.0	300	25.5
15/3/47	4.8	12.8	9.0	100	25.0
17/3/47	4.6	13.6	8.9	80	24.0
19/3/47	4.8	11.3	8.9	91	25.0
21/3/47	5.0	10.0	9.6	140	25.0

Differential leucocyte counts for the same period were:

Date	Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
13/3/47	75	13	12	—	—
15/3/47	84	8	8	—	—
17/3/47	82	8	9	—	—
19/3/47	80	8	12	—	—
21/3/47	74	12	10	4	—

Arneth counts made on the same films revealed a marked shift to the left; this was most marked between the 15th and the 17th. The icteric index of this case was 20.

Case No. 2.—The findings in this case, a Brown Gelding aged 12 years, were:

Date	R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
20/2/47	4.8	10.0	8.9	100	—
22/2/47	5.0	10.2	10.0	120	—
23/2/47	4.6	12.0	9.0	200	—

Date	Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
20/2/47	82	6	12	—	—
22/2/47	80	6	14	—	—
23/2/47	84	6	10	—	—

The animal died on the 23rd and the lesions at *post mortem* examination

were: extensive subcutaneous yellow, blood-tinged, gelatinous œdema with hæmorrhages into the musculature. Hæmorrhages were also present in the serosæ and particularly on the epicardium.

Case No. 3.—This was a very mild case of purpura and the animal was never seriously ill. The blood picture was as follows:

Date	R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
13/2/47	7.2	19.0	12.5	240	29.0
15/2/47	6.0	24.0	9.6	96	25.0
17/2/47	6.4	16.0	9.8	280	25.2
19/2/47	6.8	14.4	10.3	250	26.0
5/3/47	7.6	16.0	11.8	240	26.8

Date	Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
13/2/47	76	14	9	1.0	—
15/2/47	91	2	6	1.0	—
17/2/47	86	6	8	—	—
19/2/47	78	12	10	—	—
5/3/47	70	22	8	—	—

The mean icteric index of the blood serum was 12.

Case No. 4.—This animal was severely affected when first seen and one blood examination was made. The horse died on the 23rd and, unfortunately, no *post mortem* examination was made.

Date	R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
22/2/47	5.0	9.6	7.8	80	25.0

The differential leucocyte count was:

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
79	10	10	1	—

Case No. 5.—This case resembled very closely case No. 3 and was a very mild attack of purpura. The chief feature, clinically, was some œdema of the nostrils with a few isolated petechial hæmorrhages on the nasal mucous membrane.

Date	R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
22/2/47	6.0	12.0	10.3	140	—
24/2/47	6.3	12.5	10.5	160	26.0

Date	Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
22/2/47	70	12	14	4	—
24/2/47	65	25	5	5	—

The icteric index was 20.

Case No. 6.—One examination only was made. The animal was badly

affected and died soon after the blood samples were taken. The findings immediately prior to death were:

R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.
5.5	10.0	9.8

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
82	6	10	2	—

Arneth counts showed a strong shift to the left. The icteric index was 15.

Case No. 7.—In this case, too, only one examination was possible as the horse was destroyed on humane grounds. The animal had "gone down" and was *in extremis*.

R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
5.2	12.5	9.0	150	24.0

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
86	6	8	—	—

The icteric index was 30.

Case No. 8.—The findings in this case were as follows:

R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
7.0	12.0	11.0	400	27.0

and three days later, when the disease had almost gone:

7.2	13.2	11.0	350	27.0

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
72	18	6	4	—
68	20	6	6	—

Cases Nos. 9 and 10.—These were two cases of purpura hæmorrhagica which occurred apart from those described earlier in this paper. These two horses developed purpura as a sequel to strangles. They had both apparently recovered from the primary disease and then without premonitory symptoms they developed acute purpura. The findings in Case 9 were:

R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
6.5	20.0	10.0	200	26.5

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
80	15	4	1	—

An intravenous inoculation of calcium lactate was given after this blood sample had been taken. The horse showed marked distress immediately after the injection and died within 30 minutes. At *post mortem* examination the lesions noted were very similar to those found in Case 2 except that there was a much greater degree of hæmorrhage throughout the body. It was assumed that death was due to heart block due to the depressant action of calcium on the heart.

The other case had the following blood picture:

R.B.Cs. in millions per c.mm.	W.B.Cs. in thousands per c.mm.	Hb. in grams per cent.	Platelets in thousands per c.mm.	P.C.V. per cent.
6.0	15.0	10.0	260	—
5.8	17.2	9.8	300	—

Unfortunately, although the animal was at the height of the disease at the time of the second examination no further blood samples were taken. The animal recovered. The differential leucocyte counts for the same times were :

Neutrophils per cent.	Lymphocytes per cent.	Monocytes per cent.	Eosinophils per cent.	Basophils per cent.
76	9	14	1	—
85	9	6	—	—

Discussion

The hæmatological findings in these ten cases indicated that the disease was not characterised by a marked thrombocytopænia. The normal values for platelets in the horse were said to be within the range 90,000 to 410,000 per c.mm. (Holman, 1944). In a few of the cases the platelet count was at the lower end of the range, but it could not be described as pathognomonic. Generally speaking, the disease did not appear to have any marked effect on the platelets. These findings lend support to Greig's theory that the disease is a non-thrombocytopænic purpura.

The results of the red cell counts are in close agreement with those of Witman and Contis (1924) in that there was a severe anæmia. There was a considerable drop in the red cell count and a corresponding drop in the hæmoglobin values. The degree of anæmia was directly related, as one would expect, to the severity of the symptoms and lesions. All the fatal cases had red cell counts in the region of 5 million per c.mm. (normal values 7.0 $\pm$ 0.7 million per c.mm., Holman, 1944). There was a pronounced anæmia at the commencement of the attack and, generally speaking, the degree of anæmia was of value in prognosis. Regenerative changes were well marked in the blood of convalescent cases. As suggested by Davidson, the anæmia and consequent hydræmia must influence the production of the lesions. The anæmia will bring about some anoxæmia and nutritional disturbances of the vascular endothelium so that if, as is likely, there is also some toxic action on the endothelium of the vessels then diapedesis and transudation will readily occur.

The changes which were seen in the leucocyte picture indicate that there were toxic processes in the body. The majority of the cases showed a well-marked leucocytosis which is due mainly to a neutrophilia. Arneth counts indicated a very strong shift to the left. The average percentage of the neutrophils was 80 whereas the normal is 52 $\pm$ 12 (Holman, 1944). There was a relative lymphopænia and eosinopænia. The figures for the monocytes were surprisingly high (unless it was because the primary disease was of virus origin). Of prognostic value was a drop in the neutrophils and a return to normality of the lymphocytes and eosinophils.

It was noted that the blood sera of affected horses appeared to be deeply pigmented. This phenomenon was also noted by Bellocq (1943). As a means of assessing the degree of pigmentation the colorimetric method of Kolmer and

Boerner (1941) was used. A search of the available literature has failed to reveal any reference to the icteric index of animals. The mean icteric index of these cases of purpura was 19. Examinations of the blood sera of ten healthy horses gave a mean value of 10.

The treatment of these cases of purpura hæmorrhagica in the horse was in no way specific. Various therapeutic agents were tried with little success. The best results appeared to follow the intravenous inoculation, every other day, of 4 oz. calcium lactate in 20 oz. of water. This method of treatment is not without risk, as was shown by the fatal termination of case No. 9.

Summary

(1) The literature on the ætiology of purpura hæmorrhagica, especially in equines, is reviewed.

(2) The clinical features of the primary disease, laryngotracheitis, are described briefly.

(3) The blood picture of ten cases of equine purpura is described.

(4) The findings appear to indicate that purpura hæmorrhagica in the horse is a non-thrombocytopænic purpura.

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OBSERVATIONS ON THE VERTEBRAL COLUMN OF THE DOMESTIC ANIMALS

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[Edited Translation with Introduction and Concluding Remarks by C. W. OTTAWAY, Senior Wellcome Fellow of the Veterinary Educational Trust, Zoological Department, University of Cambridge, and A. M. HARTHORN, third-year student, Royal Veterinary College, of an article appearing in *Tijdschrift Voor Diergeneeskunde* (1946), *71,* No. 17.]

Introduction

IT has for long been popular to discuss the structural design of living things in terms of mechanical efficiency and to make comparisons between the design of Man and the design of Nature. Such study has been of immense value to the engineer. To give but one example: our knowledge of aerodynamics has

been greatly advanced by the study of the construction of the wing of the bird and by observations of a bird in flight. They are of equal value to the biologist in his appreciation of form and function in animals.

One of the most common comparisons has been that between the means of support of the mammalian tetrapod, particularly of the part played by the vertebral column, with its concomitant struts, ties, stresses and strains, and the construction of a bridge.

Of more recent authors this view has been developed by D'Army Thompson (1942), who compares the design of the horse to a bridge of two balanced cantilevers, one supported on the pier of the fore limb and the other on the hind, and discusses the arrangement of compression (bone) and tension (ligaments and muscle) members to accommodate this arrangement. Two important differences, he points out, obtain in this parallel. In the animal the two cantilever systems are unequal in magnitude and importance, due to the greater weight about one end of the body — usually the fore-end, a fact which he turns to advantage in explaining its value to the propulsive effort of the hind quarters, and the two systems cannot be considered as independent but must be considered as forming part of one unit with the load distributed over two separate piers. The chief means of accommodation to this "mechanical irregularity" is shown in the size and slope of the dorsal or neural spines of the vertebræ, and D'Arcy Thompson illustrates the nature of these spines in many animals and even enters the realms of palæontology in support of his argument. This approach has also been taken by palæontologists in their researches into posture of some pre-historic animals.

Brazier Howell (1944) also discusses the possibility of comparing the tetrapod with some kind of bridge system, but prefers the analogy of a girder supported by two pillars. In reaching this conclusion he appears to have been influenced by the consideration that the living bridge is flexible, and flexible ties (represented by ligament and muscle) can only be connected with the tension system situated above the girder (the vertebral column), a state of affairs which exists in the tetrapod.

Most writers on this subject mention but do not expand on two aspects of this comparison. The living bridge must be flexible and move; the dead bridge, rigid and stationary. This introduces complications which possibly cannot be settled quantitatively to the satisfaction of the engineer; but it is felt that even an appreciation of the factors involved can only be obtained if a much wider survey of the structures of the body is attempted—indeed, only if the body be considered as a complete functional unit, as advocated by Gray (1944). In a generalised study on the mechanics of the tetrapod skeleton, Gray refers to the complicity of the anatomical system of the vertebral column and to the fact that it is by no means easy to determine with any accuracy the precise distribution and function of the various components of the vertebral muscles. He then discusses the general nature of the external forces capable of operating about each intervertebral joint to produce movement, and this may be used as a pointer to the functional approach required.

As has been inferred, such an approach necessitates consideration of muscle

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activity and regional bone and ligament construction. In 1946 Dr. E. J. Slijper, of Utrecht, published an article on these lines, an edited translation of which is presented herewith. Since this edited translation has been prepared, the more detailed publication referred to by the author has come to hand (Slijper, E. J. [1946], *Kon. Ned. Akad. Wet.*, Verh. [Tweede Sectie], *42*, No. 5, pp. 1-128). This more comprehensive article, written in English, widens the field of investigation to many species of mammals other than the domestic; but many points of more interest to the veterinary surgeon, which have priority of place in the following article, are not mentioned.

Edited Translation

Comparison of the vertebral columns of domestic animals presents a very striking feature for consideration, namely, a marked dissimilarity in the angles formed between the long axis of the dorsal or neural spines and the long axis

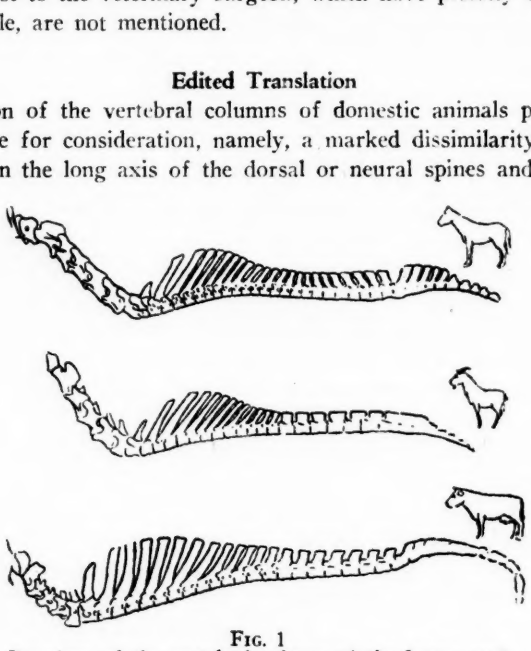

FIG. 1
Drawings of the vertebral column of the horse, goat and ox, showing the degree of slope of the dorsal or neural spines.

of the column (see Fig. 1). In the dog, cat, pig and horse they slope backwards in the anterior thoracic region, forwards in the posterior thoracic and lumbar region, a phenomenon which has been given the name "antikliny."* In the sheep and goat this feature is much less obvious, as the spines in the posterior thoracic and lumbar regions are vertical, while in the ox they even slope backwards.

Although this phenomenon was known to Galen and others of the older anatomists, it has never received a satisfactory explanation. The majority of veterinary textbooks have no comment to offer on this significant difference between the ruminant and non-ruminant vertebræ. But in the latest editions of Ellenberger-Baum, van Scheunert, Trautmann and Krzywanek, and in the recent publication of Krüger, the old theory of "antikliny," as advanced by Zschokke,

* The word "antikliny" can be translated as "opposed inclination," and it is thought that this is sufficiently illustrative of its meaning. It occurs throughout the article, sometimes relative to regions, sometimes to a particular vertebra.

is given. This theory is associated with the comparison of the construction of the vertebral column to a bridge suspended on two piles or piers, e.g., bridges at Zaltbommel and Muiden; the ligamentum supra spinalis taking up the stress from above, and the bodies of the vertebræ taking up the strain from below. The spines could be compared to the diagonals of the web-system (*cf.* reference to Brazier Howell). In actual fact, however, with a bridge of this construction the top member takes the strain and the lower member the stress, so this parallel, which has much popularity in technical literature, must be considered erroneous. Especially is this true of the comparison made by D'Arcy Thompson with the so-called cantilever bridge, as the caudal region of the vertebral column does not provide enough weight to counterbalance and the lengths of the spines do not tally. Above all, species-differentiation cannot be explained in this way. It could, however, be said that the slope of the anterior thoracic spines is favourable for this type of system; but not that they were formed by the demands of such a system.

A better insight into the construction of the vertebral column will be obtained if it is considered as part of the whole trunk, a principle laid down by Barthez as long ago as 1798 and later developed by Stasser. It is remarkable that no further interest has been displayed in this theory, in which the trunk is compared with a bow and string (tied-arch) construction (see Fig. 2). The spinal column

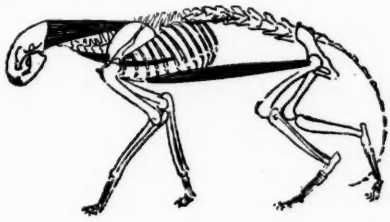

FIG. 2
Schematic drawing of the skeleton of the cat, showing the principles of the "bow and string" construction of the vertebral column and adjacent structures.

and pelvis with their muscles and ligaments form the bow; the sternum, the abdominal muscles (particularly m. rectus abdominis) and the fibres of the linea alba the string. Part of the body-weight is thrown, via the ribs and lateral abdominal muscles, on to the bow, and bending is resisted by the string. Another part actually rests on the string, and the bending movement about the bow which this will stimulate is resisted by tension (elasticity) in the bow itself. The protractor muscles of the fore limb (e.g., m. brachio cephalicus) and the retractors of the hind limb (e.g., m. biceps femoris) will tend to bend, and the retractors of the fore limb (e.g., m. latissimus dorsi) and the protractors of the hind limb (e.g., m. psoas) to stretch the bow; but which of the two actions is the more important has yet to be investigated. A construction such as this has the advantage that no pressure is effected on the supporting piers (the legs) from either the forward or backward direction. Another point is that tension is invested principally in the muscles of the back and abdomen, through which accommodation can be made to all variations of stress, load and movement. An unsatisfactory feature is the method of fixation of the string to the first rib,

a disadvantage which is, however, partly compensated for by the short length and comparative immobility of the first rib and the possible fixation action of m. scalenus.

In the vertebral column, tension is taken in part by the elasticity of the intervertebral discs and, in the anterior region of the trunk of ungulates, by the elastic ligamentum nuchæ; but in the main it is the responsibility of muscle tone. This is well illustrated in the horse, in that the back does not sag under the weight of a mounting rider but, on the contrary, straightens against the weight. The bow and string construction rests solidly on the thigh and is suspended anteriorly on the fore limbs by means of the m. serratus ventralis and m. pectoralis.

The head and neck can be compared to a loaded beam supported at one end only. The cervical vertebræ are relieved from taking the entire strain by a number of muscles which act as " stay-wires " rather like in a gate of a level-crossing. Of prime importance are the m. splenius and the m. serratus ventralis (pars cervicis). Other neck muscles (e.g., m. spinalis cervicis) are not so favourably placed for this function as they have smaller lever arms.

In the cat and other small mammals, the power of these muscles is sufficient to hold the head erect. In larger animals, however, the bending movement in the neck (i.e., weight $\times$ length of lever or weight of head $\times$ length of neck) is increased to the fourth degree, the resistance of the vertebræ against bending (illustrated by the product of the breadth and square of the height) to the third degree, and the muscle power (a question of the area of cross-section) to the second degree. It follows, therefore, that increase of absolute body-weight reacts unfavourably to the power of support. In the neck, compensation is achieved for this by increase in size of the ligamentum nuchæ. In the pig the ligament is poorly developed (the cervical vertebræ are short and steeply inclined); in the dog it is represented by a band extending from the axis to the first few thoracic spines. But in the other domestic animals it is well developed and gains attachment to the head, all cervical vertebræ and a considerable number in the thoracic region.

From the above it can be appreciated that the vertebral column acts as a springy bow which resists alteration in form, particularly by muscle tone. This resistance, capable of quickly taking up sudden changes in stress, plays an important part in maintaining the bow and also in providing an axis for transmission of the propulsive effort from hind to fore quarters.

In this system it is necessary that the neural spines provide the leverage for muscle power. In principle the slope of the spines is immaterial, as with bending of the back they will be forced apart and the interposed muscles and tendons brought into play. It is obvious, therefore, that their position and slope is dependent on *special* demands placed upon them by the muscles of the back, and their height and direction should be such as to effect the maximum effort. The differences in height and direction of these spines, as exhibited in the animals under review, is associated with differences in origin, insertion and power of the epiaxial musculature.

The first consideration is the position of the spine relative to the attachment

of the muscle. The most favourable position appears to be perpendicular to the muscle fibres. In Fig. 3, let it be assumed that vertebra V is moved by

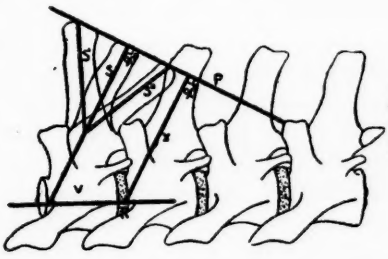

FIG. 3
Schematic drawing of four lumbar vertebræ, indicating the most favourable position of the spine S—(S) for the movement of vertebra V by muscle P with lever X about fulcrum R.

muscle P about fulcrum R and let it be further assumed that muscle P is of such strength that it requires a lever X to effect the movement. The value of the lever X is dependent on the position of the spine S (*cf.* S., S', S''), and it is obvious that of all possible positions the perpendicular (S) is the most favourable, as in that position the spine is shortest—in other words, the position is the most economical.

Rarely, if ever, is only one muscle attached to a certain spine. Reference to Fig. 4 shows that with two antagonistic muscles P and q, possessing approxi-

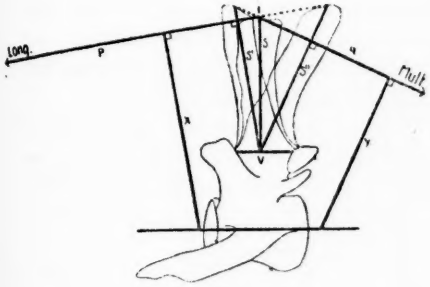

FIG. 4
Schematic drawing of one lumbar vertebra, indicating the most favourable position of the spine S—(S) for the movement of vertebra V by two antagonistic muscles P and q with approximately equal lever arms X and Y.

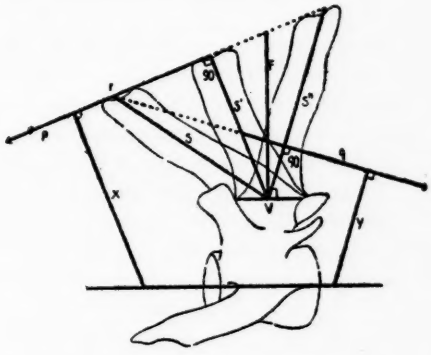

FIG. 5
Schematic drawing of one lumbar vertebra, indicating the most favourable position of the spine S—(S') for the movement of vertebra V by two antagonistic muscles P and q with unequal lever arms X and Y.

mately the same length of lever arm X and Y, the most favourable position for the spine is at S, i.e., that which establishes a middle course between the perpendicular in P(S') and in q(S''). If the levers X and Y vary greatly in length, as is shown in Fig. 5, a position perpendicular to the muscle with the longest lever (S', muscle P and lever X) will be most favourable. If muscle P requires a longer spine to effect its action, the attachment of q will be correspondingly lengthened to a neighbouring spine which provides q with a better lever. In most cases it can be said, therefore, that when two or more muscles

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are attached to the same spine, the spine will endeavour to assume a position perpendicular to the direction of the most powerful muscle. It is not easy to express size in figures, but in practice the development of muscles indicates that this is so.

An angle of 90° between spine and muscle ensures a better union of tissue elements. In all cases the actual union is effected by tendon fibres, although in some instances the fibres may be so short as to give the impression of direct muscle attachment. Tendon fibres may penetrate the periosteum at the point of contact and ramify in the compact bone where they encircle the osteones, or they may become confluent with the periosteum enclosing the whole bone, in which case the inner layer of the periosteum encircles the outer osteones of the compacta. (See Fig. 6.) This looping of fibres around either the entire bone or individual

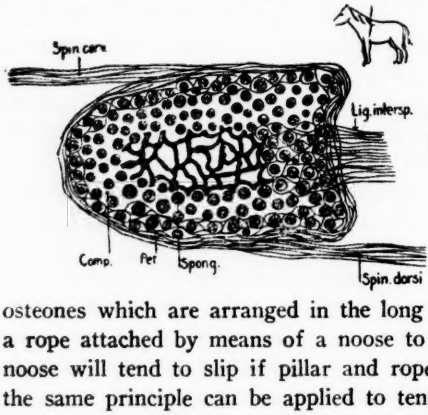

FIG. 6
Schematic drawing showing method of attachment of tendon fibres to periosteum and bone. Per = periosteum, comp = compacta, and spong = spongiosa of bone.

osteones which are arranged in the long axis of the spine may be compared to a rope attached by means of a noose to a pillar. When the rope is pulled the noose will tend to slip if pillar and rope are not mutually at right-angles, and the same principle can be applied to tendon-bone union in that stresses on the attachment will be greater when the pull is not at right-angles.

It is now opportune to apply the principles to the arrangement of vertebral spines in the domestic animals. In the neck and anterior thoracic region, an area which shows a marked degree of similarity in all mammals, the short spines of the cervical region are approximately perpendicular to the fibres of the liga-

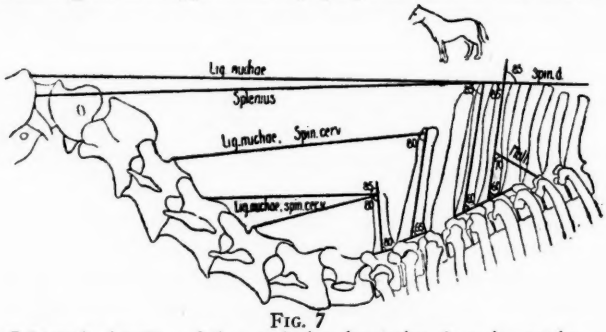

FIG. 7
Schematic drawing of the cervical and anterior thoracic vertebræ of the horse, showing the relation of muscle and ligament fibres to skeletal structures.

mentum nuchæ and m. spinalis cervicis. The direction of these latter structures bears a similar relationship to the almost vertical first thoracic vertebra (see

Fig. 7). The angle between the second-fourth thoracic spines and the most important structures attached to them, the ligamentum nuchæ, m. splenius and m. spinalis dorsi,* is also approximately 90°, and the increase in height of these spines is in keeping with the lever requirements of the m. splenius and ligamentum nuchæ.

Associated with the next series of thoracic spines are the short bundles of the m. semi spinalis and, more important, the m. multifidus, which run between the spines and the mamillary processes of more posterior vertebræ. Their special duty is to provide the necessary tension in this region. In contrast to the activity of the larger bundles of the m. longissimus dorsi and spinalis, these short muscles are responsible for the stronger slope of the spines which attain an angle of 50° to 30°. In the ox this pronounced feature may be associated with the strongly developed m. rotatores. In most dogs the backward slope of the spine in this region is greater at the base, where the m. multifidus originates, than at the summit, where the spinalis dorsi is attached. Thus the requirements of both muscles are met and a characteristic bend is given to the spine in this species.

The posterior regions of the column, however, as shown in Fig. 1, demonstrate a marked species-differentiation. This is due to changes in muscle attachments, and since the static requirements of the column are similar in all domestic animals, the main differences must be associated with the varying mode of locomotion. Hence the state of "antikliny" appears to have a locomotory basis.

The nature of the vertebral spines have a special bearing on the method of galloping. Dog, cat and pig adopt the so-called leaping gallop, which is characterised by a clearly visible bending and stretching of the back (see Fig. 8). The

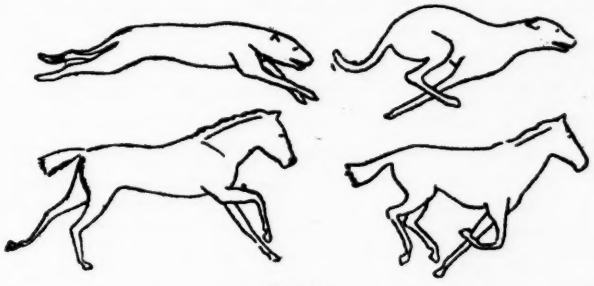

FIG. 8
Trace drawings demonstrating vertebral movement at the gallop. *Left*—phase of maximum stretch. *Right*—phase of maximum bend. *Above*—the dog. *Below*—the horse.
[From photographs by Muybridge (1899), "Animals in Motion."]

vertebral column is flexible, and research has shown that movement is located principally in the region of the so-called "diaphragmatic" vertebra. This is the vertebra where a change in direction of the articular surfaces of the articular processes occurs. In the anterior series of thoracic vertebræ the articular processes

* Reference is constantly made to the various portions of the "spinalis muscle." These in effect can be considered as part of the complex longissimus dorsi muscle. Advantage, however, has been taken in this work to refer to accepted regional portions in order that they may be linked with regional vertebral construction and movements of the part.

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are approximately horizontal, in the posterior thoracic and lumbar region vertical. In the cat this change, coincident with the change in slope of the spines, occurs at the tenth thoracic vertebra. In the pig and dog the tenth is the "diaphragmatic," the eleventh the "antiklinæ," and these vertebræ have also the smallest spines, which is conducive to movement. At the gallop the centre of motion of the vertebral column is situated about a point on or near the "diaphragmatic" and "antiklinæ" vertebræ.*

The musculature of the back is adapted to the nature of this task. The most important muscles are the m. longissimus dorsi and the m. spinalis and semispinalis dorsi. The first originates in serrated bundles from the ribs and transverse processes of the thoracic and lumbar vertebræ. The bundles from the posterior thoracic and lumbar regions are inserted mainly on to the ilium, and this portion is designated m. ibo-lumbalis; while those from the anterior thoracic region and the ribs form a series of long tendons, partly inserted into the mamillary processes but principally on to the summits of the vertebral spines posterior to the "antikline." The bundles of m. spinalis and semispinalis (multifidus) originate anterior and are inserted posterior to the "antikline" vertebra, on the spines and mamillary processes respectively. Thus all of these muscles show favourable adaptations for the movement of the vertebral column as seen in the leaping gallop. The fact that no, or at the most only very small, muscle bundles are attached to the "antikline" and neighbouring vertebræ explains why long levers are unnecessary and the spines are consequently small.

As the m. longissimus dorsi is by far the most important of the above-described muscles, it is to be expected that the spines of the post-diaphragmatic vertebræ will be perpendicular to the direction of the tendon of this muscle. This

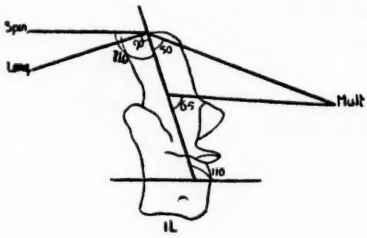

FIG. 9
Schematic drawing of the first lumbar vertebra of the horse, showing the slope of the spine at right-angles to the line of the most important muscle (m. longissimus dorsi).

is the case (see Fig. 9), and is the explanation of the forward slope of these spines in the dog, cat and pig.

The so-called horse-gallop of the horse, goat and sheep differs from the above in exhibiting less movement of the vertebræ, a feature which ensures a comfortable seat on the back of a galloping horse. In contrast to the dog, there is little difference between the phases of maximum bending and stretching of the vertebral column in a galloping horse (see Fig. 8). The movement that does occur is localised to the point between the last lumbar and first sacral vertebræ,

* Presumably the author is referring here only to the centre of motion in the leaping gallop, as the position of the diaphragmatic vertebra in larger animals is not at the centre of motion.

a movement which enables the horse to bring the hind quarters under the body. Experimental evidence has shown the vertebræ of the trunk to be extremely rigid. Only in the region immediately anterior to the "diaphragmatic" vertebra is a small degree of bending possible, and this bending plays an important part in grazing. Further, the cervical vertebræ, in the domestic as in all other mammals, can only be moved groundwards to a position where all are in a straight line. A grazing horse places one fore limb forwards, drops the trunk as far between the shoulders as possible with the help of m. serratus vertralis and m. pectoralis, bends the back in the region of the tenth-fifteenth thoracic vertebræ, and then, by inclining the head downwards on the atlas, just reaches the ground. The restricted movement of the trunk is due chiefly to the high and closely packed thoracic spines and the nature of the articulations in the lumbar region, where the articular processes and others interlock with each other in such a way that movement in this region, especially in ruminants, is almost out of the question.

As vertebral movement in these animals is almost entirely restricted to the lumbo-sacral joint, it is not surprising that the muscles show a tendency to adopt to these changed conditions. The most striking of these is the tendency of the m. longissimus dorsi to be inserted almost entirely into the sacral region instead of the almost immovable lumbar vertebræ. This does not completely follow in the horse, where a large part of the insertion is still in the lumbar region. On this account the lumbar spines of the horse do have a forward slope, but the degree of "antikliny" cannot be compared with that of the pig or carnivora.

In the goat and sheep, as in the deer and gazelle, only a few weak fibres of m. longissimus dorsi are inserted into the lumbar region; these spines are therefore vertical. In the ox the insertion is entirely restricted to the sacral region; therefore m. multifidus, with its postero-ventrally running fibres, becomes the most important muscle attached to the lumbar spines, which are presented in a position perpendicular to the direction of the fibres of this muscle, i.e., they slope backwards. The angle formed between the high thoracic spines and the slightly opposed bend of the back is also favourable for the attachments of m. spinalis dorsi.

The spines of the sacral vertebræ in all mammals are either upright or bend backwards. This phenomenon has not yet been fully investigated; but it is probably due to the fact that several muscles of the hind limb (e.g., m. biceps femoris and parts of the gluteal muscles) originate from this region and the necessity of their postero-ventral pull has influenced this backward slope.

This explanation for the different length and direction of the vertebræ spines can be applied to other than the domestic mammals. Examination of 90 skeletons and the arrangement of the back muscles as observed in 80 different species of mammals has confirmed this view.

In 1939 a three-month-old goatling born without fore limbs was received for observation. The goat died at the age of one year. During progression the animal jumped like a kangaroo. The skeleton and musculature showed many interesting modifications to this mode of progression. From the nature of the

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walk the muscles of the back would be expected to have exerted a much greater effort than in the normal animal. They were not markedly abnormal; but the spines in the anterior thoracic region were definitely longer than usual and thus the m. spinalis dorsi was provided with increased leverage. Also, as this muscle had now assumed a greater importance than either the m. splenius or ligamentum nuchæ, the thoracic spines, instead of sloping backwards, were perpendicular to the long axis of the column. The spines in the lumbar region were also adapted to suit the direction of the m. spinalis.

A detailed publication of these investigations will appear in *Kon. Akad. Wetensch.*, Amsterdam, 1946.

Concluding Remarks

This article is in a sense provocative and advances suggestions which will not meet with universal agreement. The criticism of D'Arcy Thompson is hardly fair, in that D'Arcy Thompson's words were not meant to be final on this particular issue. In the main he contented himself with advancing principles, although he did in fact suggest many of the approaches adopted by Slijper, which incidentally have been considered by other workers.

It is not clear to which tissue is ascribed the predominant role in determining the contour of the vertebral column: the bones or the muscles. The general trend of the article suggests that the length and direction of neural spines are determined by muscle requirements. But in the example quoted of the goatling born without fore limbs it is possible to arrive at either conclusion, as it is first inferred that the spines initiated the change or form, and later that their shape was in accordance with the requirements of the m. spinalis.

Others will criticise the view put forward of the most advantageous position of the spine relative to the attachment of muscles. When the varying direction of the slope of the spines during movement and the large number of muscles gaining attachment to them are taken into account, there must be instances when powerful muscles are forced to accept a compromise position; but this does not necessarily destroy the conception of the most advantageous position.

It could be mentioned that the direction of the fibres of the lumbar multifidus in the ox is not always as quoted, for the lumbar spines are often upright. Again, it can hardly be said that a completely satisfactory answer is given for the forward slope of the lumbar spines of the horse, other than the fact that the m. longissimus dorsi is attached to them. It might have been more profitable to have linked this latter point with the backward slope of the sacral spines of the horse and have elaborated further on lumbo-sacral movement and its pronounced effect on the propulsive effort, particularly at the gallop. The attachment of m. biceps femoris to the sacrum is mentioned as the probable cause of the backward slope of the sacral spines. Similarly, the absence of a sacral origin for the m. biceps femoris in the dog might have been associated with the vertical direction of the sacral spines in this species and both factors related to the modes of locomotion in horse and dog, particularly the parts played by the hind limbs.

Nevertheless the article is very stimulating, the functional approach is extremely sound and many of the analyses are direct leaders for similar comparisons in other areas of the body.

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SOME EXPERIENCES WITH COLCHICINE IN THE TREATMENT OF MAMMARY TUMOURS IN THE BITCH

By R. W. L. CHESNEY, M.R.C.V.S.
Porlock

I CONSIDER the treatment of mammary tumours falls into three main sections: (1) seedlings; (2) medium-sized growths; and (3) operational.

(1) Seedlings vary in size from pin-head to pea and may be single or multiple in one or more glands. Usually, they are palpable in middle-aged bitches and may never alter in size throughout the life of the animal. Sometimes, following œstrum, one isolated seedling may start to increase in size and, if not treated, may become as large as an orange, or even larger, depending mainly on the amount of loose skin in the area. Œstrum is not the stimulant which starts this activity, but it is responsible for a certain amount of reaction in the glands and this in turn sometimes vitalises the seedling. So long as none of the seedlings appears to be increasing in size, I think the best treatment is to leave well alone.

(2) By medium-sized growths, I mean those which are not greater than a walnut. They may be found in bitches of any age and may number several in varying stages of growth. Sometimes a tumour will attain the size of a bean or a walnut, and then harden and remain quiescent, but very often they continue to grow and during this growth period, which may vary from a few months to a year or two, the animal sometimes shows symptoms of pain at the site as well as general depression and a change of temperament. Surgical interference at this stage may ensure complete freedom from tumour formation for the rest of the animal's life, but it is common experience that later, perhaps only a few months, another growth commences to form, either at the same spot or in another gland. It is often impossible to forecast if another growth will occur because of the absence of seedlings of a palpable size. Here, then, is where I consider the use of Colchicine is most valuable. Instead of surgical interference, a series of graduated doses of Colchicine is given over a period of three weeks. Following the initial dose of 1/40th of a milligramme, the animal will often show a general reaction in the form of depression, lethargy and inappetance lasting possibly three days. There may also occur a similar but milder reaction after the second injection of 1/40th strength, three days later. The injections are repeated at three-day intervals and comprise two of 1/40, two of 1/20 and two of 1 mgm. per c.c., the size of the dose being 1 c.c. The injection may be made into the tumour itself, but this causes pain at the time of injection and for several days afterwards, and

also gives the bitch good cause to object to any further treatment, and as it does not appear to make very much difference which route is adopted, I usually use the subcutaneous method. The earliest noticeable reaction in the tumour occurs about two to four weeks after the last injection. In some cases it takes the form of a diminution in size (caliper recordings), and this is often a continuous process —some growths, mainly small ones, gradually disappearing altogether. The majority, however, show a gradual reduction in volume until they are about two-thirds of their original size, and during the process become very indurated and sometimes nodular, and remain thus indefinitely. I have not encountered any fresh growths in any of the 38 cases treated. In nearly all the bitches treated in this manner the owners have recorded a marked improvement in general health and temperament. Two animals failed to respond to treatment and the tumours were removed surgically.

(3) In this section are found all those tumours which, by virtue of their size, condition or lack of response to Colchicine treatment, have to be removed surgically. These cases are usually the result of neglect on the part of the owners. As a rule, the size of the tumour varies in direct ratio to the size of the bitch, e.g., it is common to find that in terriers it is imperative to operate when the tumour has attained the size of an orange owing to the overlying skin losing its tone and ulcerating; whereas in a retriever the urgency does not arise until the growth approximates double that of the terrier. Usually, there is only one such tumour on the animal, but there may be one or several smaller ones in various stages of development. If there is only one tumour and it is a large one, then surgical removal may give the bitch a clean bill of health with no recurrence of the trouble. But very often a fresh growth appears either at the same place or in another gland, and its rate of growth is very rapid—sometimes only three months elapses before there is another the same size as the original. It is seldom that a second operation is performed—the bitch is usually destroyed. I have found, however, that bitches which have been treated with Colchicine in an attempt to control or reduce these enormous tumours have very seldom shown any sign of a recurrence following surgical interference. This is an interesting point and indicates that any seedlings or medium-sized growths resident in the other glands have been influenced by the Colchicine. I have no doubt on this point, because in two cases in which I removed gross tumours there were smaller growths elsewhere which were not disturbed during the operation and showed no tendency to grow afterwards. My practice nowadays, if there is no immediate urgency to operate, is to give the animal a series of injections of Colchicine and operate about a fortnight later. Apart from giving the animal protection against the sprouting seedling, the drug also exerts a slight effect on the tumour in the form of a hardening of the substance, making it more discrete and easier to separate from the surrounding tissues. If no injections had been given before operation, a course is given afterwards.

I append a series of case reports in amplification of my theme. I am firm in the opinion that Colchicine is a most useful aid in the treatment of mammary tumours. The idea was first propounded by Dr. E. C. Amorosa, of the Royal Veterinary College, and it may be that if we continue to work along the lines enunciated by him we may pave the way to the solution of the cancer problem.

Case Reports

SECTION (2): MEDIUM-SIZED GROWTHS TREATED WITH COLCHICINE.

Animal	History	Treatment	Caliper Measurements		Sequel
			Initial	2-4 *mths.*	
7-yr.-old spaniel C16	One tumour in one gland. Seedling in another. 10 mth. development and now rubber-like but painless.	6 injections	25 mm.	20 mm.	Smaller, harder. Seedling quiet.
5-yr.-old pekingese C17	Rapid growth of one tumour in one gland. In 3 mths. size of walnut and skin ulcerating and infected.	6 injections Local hot antiseptic foments	30 mm.	22 mm.	Skin healed in 14 days. By 6th week size of bean and hard.
5-yr.-old sealyham C18	One tumour in existence 3 mths. Size of bean and painful. Bitch depressed.	6 injections	20 mm.	15 mm.	Examined 1 year later. 10 mm. and hard.
9-yr.-old sealyham C21	Two tumours in two glands. Size of walnut and grape. Both impressible and painless.	6 injections	29 mm. 18 mm.	21 mm. 10 mm.	Reduction with hardening. Disappearance in 6 months.
6-yr.-old spaniel C22	One tumour the size of a grape—3 mth. growth—slightly tender.	6 injections	20 mm.	15 mm.	Slight hardening. Painless.
4-yr.-old terrier C25	One tumour which increased from 10 mm. to 20 mm. in three months prior to treatment.	6 injections	20 mm.	10 mm.	Slight hardening. Six mths. later 5 mm. and hard.
10-yr.-old retriever C26	Three tumours and two seedlings in two glands. One size of plum. Two size of walnut.	6 injections	50 mm. 35 mm. 35 mm.	56 mm. 25 mm. 28 mm.	Removed surgically 4 months later both approximate 20 mm. and hard. Seedlings unchanged.
7-yr.-old terrier C27	One tumour size of walnut and several seedlings scattered throughout glands. Tumour in evidence eight months.	6 injections	31 mm.	14 mm.	Six months later 14 mm. and hard. Seedlings unchanged.
7-yr.-old dachshund C29	Three grape-sized tumours in three glands. Developed within five months. Bitch sensitive when tumours felt.	6 injections	20 mm. 23 mm. 18 mm.	18 mm. 16 mm. 10 mm.	Not much change in 4 months. Harder. "
9-yr.-old spaniel C35	One walnut-sized tumour and three seedlings. One year old growth.	6 injections	33 mm.	33 mm.	Six months later 42 mm. Removed surgically. Seedlings unchanged 12 months later.

SECTION (2): MEDIUM-SIZED GROWTHS TREATED WITH COLCHICINE.—*Continued.*

Animal	History	Treatment	Caliper Measurements		Sequel
6-yr.-old cairn C8	One seedling which increased from 5 mm. to 11 mm. in 12 mths.	6 injections	11 mm.	8 mm.	Hard and nodular.
5-yr.-old terrier C11	Two tumours in one gland. Both about size of grapes. Bitch was depressed and resented any pressure on them.	6 injections 6 injections repeated	25 mm. 22 mm.	22 mm. 15 mm.	Very little change and still tender. Harder and insensitive. Bitch in better health.
C3, 7, 12, 13 and 14	These five cases were similar to C27, but the period of growth varied from three to 14 mths.	6 injections in each animal	32 mm. 30 mm. 35 mm. 38 mm. 35 mm.	20 mm. 22 mm. 21 mm. 22 mm. 26 mm.	Harder and some were nodular. Seedlings unchanged.
C20, 23, 30, 31, 34, 37 and 38	These seven cases were similar in that they all had one tumour only and no obvious seedlings. No tenderness in the growths or depression in the animal. Growth period 3 to 9 months.	6 injections in each animal	15 mm. 19 mm. 18 mm. 20 mm. 20 mm. 24 mm. 19 mm.	9 mm. 12 mm. 7 mm. 12 mm. 15 mm. 14 mm. 12 mm.	Harder and some were nodular. No sign of any fresh seedlings.
C4, 10, 19 and 28	Four cases very similar. Growth period within 6 months in every case. Bitches were three to four years old.	6 injections in each animal	12 mm. 11 mm. 14 mm. 14 mm.	0 mm. 0 mm. 0 mm. 0 mm.	Slight swelling during treatment. Then gradually absorbed.

SECTION (3): OPERATIONAL.

C1, 2, 6, 15, 24, 32, 33 and 36 Ages varied from 5 to 14 yrs.	These eight cases were bitches which had gross tumours and either one or two medium-sized growths in other glands and sometimes a few seedlings. Growth period was anything from one to three years.	Mostly 6 injections before operation, but some afterwards	The gross tumour usually numbering one per bitch, varied in size from that of an orange to a large potato, i.e., 60 to 120 mm. After its removal, the medium-sized growths remained quiescent or became reduced in size. There was no recurrence of tumour at the site of operation.
10-yr.-old spaniel C5	A large tumour for six months, now ulcerated and discharging. Another medium-sized in another gland. Animal was in a toxic state.	Rapid surgical removal of both tumours	Bitch was very ill for some days. Three months later a fresh growth appeared at the site of the original medium-sized growth, but a series of Colchicine injections checked it at 25 mm.
8-yr.-old sheepdog C9	One large tumour which had burst and left a crater 85 mm. in diameter. Two pea-sized seedlings in other glands.	Antiseptic treatment of crater until free from pus and then the surface was painted with increasing strengths of Colchicine	Six injections were given and the crater healed and left a small nodule 20 mm., which was examined 9 months later and found quiescent.

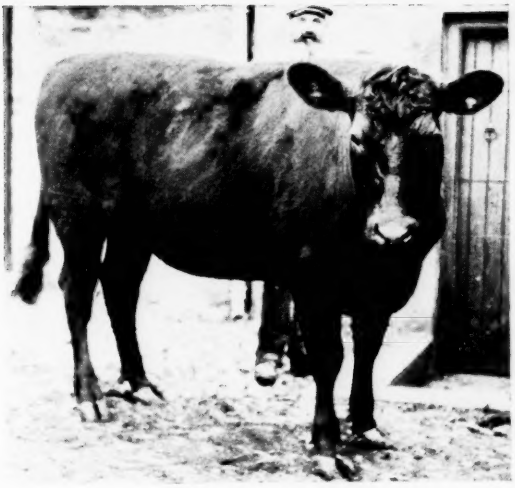

FIG. 1
Aberdeen Angus freemartin.

FIG. 2
Genitals of Aberdeen Angus freemartin.
Bl. = Bladder.
Va. = Vagina.
V.g. = Vestibular glands.
Ut. = Uterus.
Ut.t. = Uterine tubes.
V.s. = Vesiculæ seminales.
V.d. = Vas deferens.
Te. = Testes.

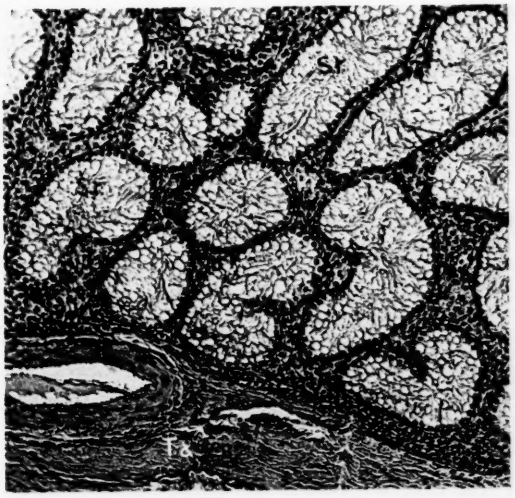

FIG. 3
Micro-section of Aberdeen Angus sex gland.
T.a. = Tunica Albagenia. S.t. = Seminiferous tubule.
P.t. = Parenchyma testis.

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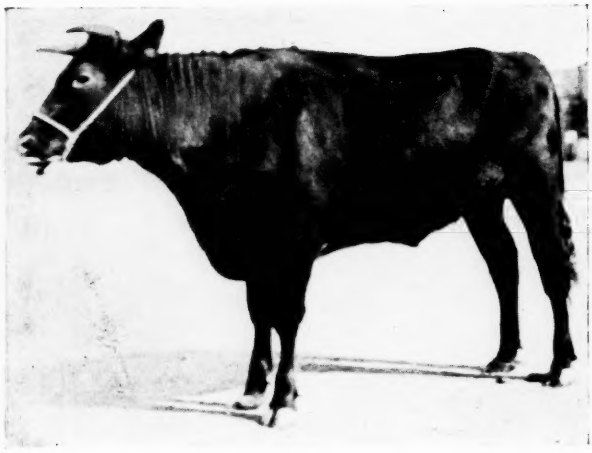

FIG. 4
Shorthorn freemartin.

FIG. 5
Genitals of Shorthorn freemartin.
Va. = Vagina.
V.g. = Vestibular glands.
Ut. = Uterus.
Ut.t. = Uterine tubes.
V.s. = Vesiculæ seminales.
V.d. = Vasa differentia.
Te. = Testis.
Ep. = Epididymis.
Bl. = Bladder.

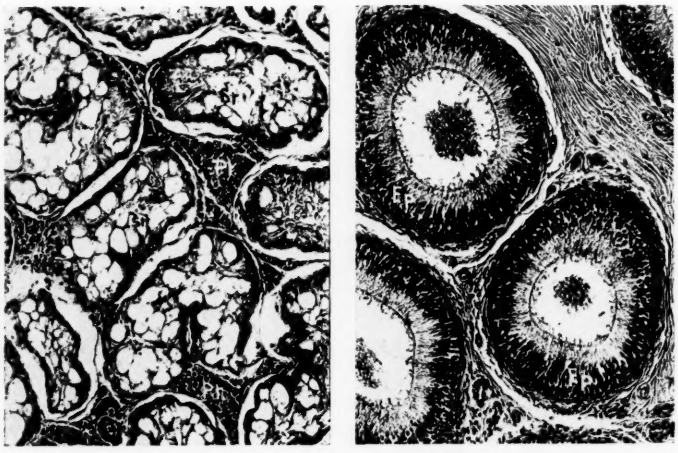

FIG. 6. Micro-section of sex gland of Shorthorn freemartin.
S.t. = Seminiferous tubule. P.t. = Parenchyma testis.
Ep. = Epididymis tubules cut across and lined with hair cells.

FIG. 7
Caprine freemartin. Anglo-Nubian single kid.
Note enlarged clitoris.

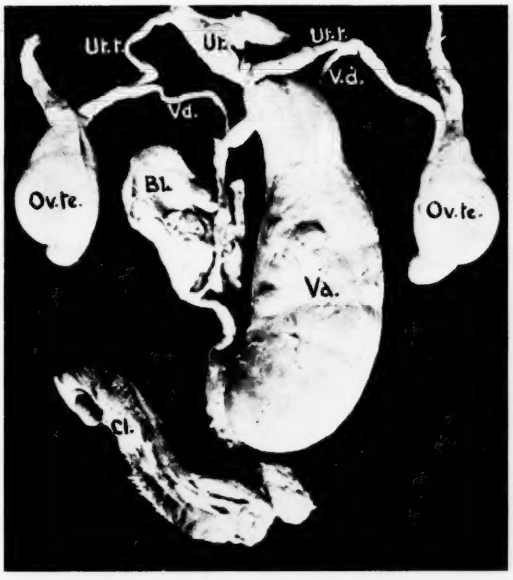

FIG. 8
Genitals of Caprine freemartin. Anglo-Nubian single kid.
Cl. = Enlarged clitoris. Ut. = Uterus.
Ut.t. = Uterine tubes. Ov.te. = Ovi-testes.
Va. = Vagina imperforate and distended.
V.d. = Vasa deferentia. Bl. = Bladder.

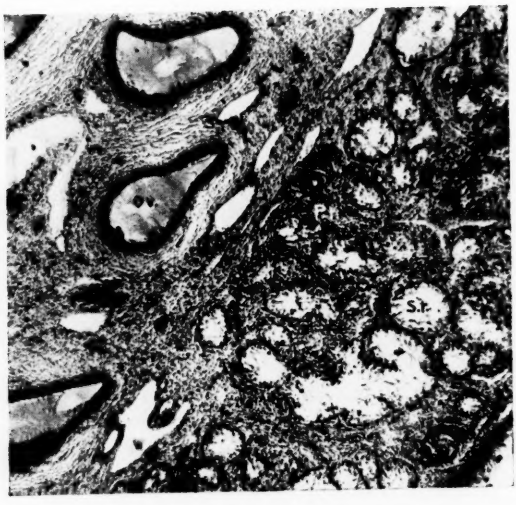

FIG. 9
Ovi-testis of Caprine freemartin—a single Anglo-Nubian kid.
Ov. = Ovum. S.t. = Seminiferous tubule.
P.t. = Parenchyma testis.

THE FREE-MARTIN*

By EMERITUS PROFESSOR ALEX. LOW
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MART is an old Scotch word meaning a beast of the cattle kind that did not breed, either a sterile heifer or a stot. In former times farmers about Martinmas used to slaughter a mart, salt and put it in barrels for winter use.

John Hunter, the eighteenth century famous Scottish scientist and surgeon, was introduced to the subject of the free-martin by Dr. Edward Jenner, who was his assistant at the hospital and lived with Hunter for two years. Jenner had dissected the genitals of several free-martins. Hunter then procured three free-martins and kept them at Earls Court. On their slaughter, Hunter dissected the genitals of the free-martins. Later, the dissections were presented to the Hunterian Collection in the Royal College of Surgeons.

D. Berry Hart figured and described a testis with spermatozoa. As I had not seen this in any of my micro-sections of free-martin sex glands, with the permission of Sir Arthur Keith, who was then Conservator of the Museum, I went and studied Hunter's dissections of free-martin genitals. I found that D. Berry Hart's description of the testis with spermatozoa was not from one of Hunter's free-martins but from a ram with hypospadias. We discovered Hunter's dissection of free-martin genitals on the shelf of a nearby case. They were both Hunterian preparations, that of the ram with hypospadias having the number 678 and that of the free-martin genitals 678.3—hence the mistake.

Breeders of Aberdeen Angus and Shorthorns in the North-east of Scotland were very helpful in sending me the fœtal membranes or clenses when bull and heifer twins were born and, after about three years, informing me when the heifer was to be sold for slaughter.

The photograph of an Aberdeen Angus free-martin (Fig. 1) shows a broad forehead, full brisket, nice straight back and hind quarters, practically no udder and four small teats; further, on pinching the hide it is thicker than that of a normal heifer and like that of a bull. Genitals of the same (Fig. 2) and micro-section of sex gland (Fig. 3) show non-functional seminiferous tubules and parenchyma testis.

The Shorthorn free-martin (Fig. 4) shows the same characteristics as the Aberdeen Angus free-martin. Genitals of the same are shown in Fig. 5; one vas deferens was traced to the epididymis and the micro-section of the sex gland (Fig. 6) shows seminiferous tubules, parenchyma testis and a section across the epididymis tubules lined by hair cells.

Free-martins are very common in pigs, and a dissection of the genitals of a pig was shown and a micro-section of the sex gland.

A series of preparations with communications between the arteries and veins of the clenses of bull and heifer twins were shown. Further, ram and ewe clenses were shown where there are no communications between the blood vessels of the clenses and we do not find free-martins among sheep, although imperforate

*Paper read to the Former Students' Association of the North of Scotland College of Agriculture, Aberdeen.

anus and hypospadias are not uncommon. This tends to support the view that free-martins are due to the mixing of the male blood with that of the female.

Keller and Tandler in 1916 suggested that the internal secretion of the bull acting at an early stage on the genital system of the heifer converted her into a free-martin.

I have reliable evidence that five cases of single heifers became free-martins. Further, from statistics obtained from the Herd Books of Aberdeen Angus and Shorthorns, I found that more free-martins of these breeds were slaughtered than there were twins to account for.

Numan is the only one who is of opinion that the mixing of the blood of the bull and the heifer does not account for the free-martin in every case.

Owners of pure breeds of goats in England were concerned that even single kids became caprine free-martins. They sent me the clense or clenses and, later, the live kids, which were kept on my brother's farm.

An Anglo-Nubian single kid (Fig. 7) was shown and genitals of the same (Fig. 8), showing enlarged clitoris; at the vaginal orifice there was a small depression which was imperforate, so that the vagina was distended. The vasa differentia on either side were traced to the sex gland and micro-section (Fig. 9) was a non-functional ovi-testis.

Caprine twin membranes of male and female kids injected showed a broad band passing round the membranes without any anastomoses, and the female kid was a caprine free-martin.

Thus the problem of the free-martin has still to be solved.

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AUSTRALIA SAFEGUARDS ANIMAL HEALTH

By A. INGLE HALL
Australia House, London.

In the last few weeks it has been necessary for the Australian Government to introduce measures affecting both the import and export of livestock. This does not signify a restrictive trade policy, but circumstances have made these precautionary measures necessary.

During the war domestic animals in many countries north of Australia were destroyed by enemy action. In other countries the exceptional demands of war led to a serious depletion of flocks and herds. These losses had to be replaced,

and during the past two years Australia has received many overseas orders for cattle, horses, sheep, poultry and even dogs.

Efforts were made to satisfy as many of these orders as possible, including cattle for the Philippines, sheep and poultry for Singapore, and horses for as distant a market as Abyssinia.

This was not a case of disposing of a surplus of livestock, but of drawing on Australia's own supplies to meet the urgent needs of other countries. Last month, the Government was obliged to review the position, and limit licences for further exports to very special cases.

Such restrictions, imposed reluctantly, were dictated by a domestic problem. During the war Australia was an important supplier of meat and hides, and, for the time being, the shipment of meat to Allied countries became a more urgent problem than the maintenance of flocks and herds. Shortage of manpower on farms also contributed to a decline in livestock, particularly on dairy farms, and a series of abnormally dry seasons in Queensland and New South Wales took a disastrous toll of sheep. The number of sheep in Australia is still about 100,000,000, but that is about 25,000,000 below the number in 1942.

Apart from the obvious need to re-stock farms where these heavy losses of sheep occurred, there are two special reasons why Australia cannot afford to continue the unlimited export of livestock. Many former Servicemen are going on the land, with Government assistance. They have received intensive training in agricultural colleges and elsewhere, and large stations have been sub-divided to provide them with holdings of good land large enough to give them every prospect of success. When the need arose to stock these farms, it was found that enough stock would not be available if unlimited exports were allowed.

The other difficulty is that Australia has assumed heavy obligations to supply food, including meat and a wide range of dairy products, to other countries. To meet these obligations, it is necessary to conserve and if possible increase the stocking of farms throughout the country.

The reasons for closer control of imports of livestock, especially by air, are quite different. In a primary-producing country like Australia, the maintenance of animal health and exclusion of pests and diseases affecting animals are of paramount importance. In the days before the development of large-scale air freighting, Australia's distance from other countries was an impediment to overseas trade, but the long sea passage automatically provided a period of quarantine. This enabled Australia to exclude many animal diseases prevalent in other countries, and to take effective measures to combat pests and diseases introduced before the importance of a close supervision of imports was fully realised.

There would be little advantage in reducing the time of travelling to Australia, by substituting air for sea transport, if this merely extended the period of livestock quarantine, either in the exporting country or in Australia. On the other hand, it would be a most short-sighted policy to relax the quarantine requirements now and undermine all the precautionary measures taken over a period of many years.

XUM

Australia has learned the importance of safeguarding animal health by costly experience. Some years ago, the poultry disease, psittacosis, was introduced, and thousands of birds had to be destroyed before the disease was eliminated. Last month, a consignment of hides from another country was found to be infected with anthrax, and had to be destroyed. These, and many similar incidents, have shown that the price of maintaining healthy flocks and herds in Australia is unceasing vigilance, and it is more certain and economical to prevent the introduction of diseases than to eradicate them when they have been introduced.

The more positive aspect of this policy is that Australia is applying more money and scientific knowledge to research to improve the health and raise the standard of livestock of all kinds. When it again becomes possible to permit the unrestricted export of livestock, the Australian breeder should have even better and healthier stock to supply to buyers overseas.

REVIEWS

(i) Reports of the Chief Veterinary Surgeon, Southern Rhodesia, for 1941, 1942, 1943, 1944, 1945 and 1946.

(ii) Reports of the Director of Veterinary Research, Southern Rhodesia, for 1942, 1943, 1944 and 1945.

THESE reports, received from the Southern Rhodesia Government Veterinary Service, give a picture of its activities during the war years.

Owing to the release of professional and lay veterinary staff to the Forces and to retirements and the difficulties encountered in recruiting suitable replacements, the work of the Service was not increased beyond the control of major outbreaks of disease and meat inspection. The difficulties experienced in finding adequate and reliable transport are mentioned as having had an adverse effect on the efficiency of the Service.

Most of the report deals with the control of the diseases of cattle, which is the main activity of the Service. It is most interesting to read in the Chief Veterinary Surgeon's report of the changes in the animal disease situation in this large tract of Africa over a period of six years. A continuous war is waged against the endemic diseases in the area, and although some diseases of cattle hitherto unknown in Southern Rhodesia appear to have entered from neighbouring countries, the colony has been kept free from the more serious pan-African enzootics.

The condition of cattle in the country appears to be directly relative to the quality of the grazing, which, in turn, is dependent on the variable rainfall. This factor has a serious effect on the ability of the cattle to stand up to the rigorous dipping measures which are a continuous necessity in controlling the endemic tick-born diseases. (Some 3,800 cattle-dipping tanks are maintained.)

In 1943, after a disease-free period of six years, Foot-and-Mouth disease reappeared. This was attributed to the spread of infection from wild game to domestic stock. The method of control consisted of ensuring the rapid spread

of the disease among all susceptible cattle in an infected area, in order to reduce quarantine time. A new method of infection, by the intra-muscular inoculation of living virus, was evolved. Almost a 100 per cent. infection was procured. Over 300,000 inoculations were made and, with the assistance of cordons and the maintenance of cattle-free areas, the disease was completely reduced.

Lumpy Skin disease appeared in the colony in 1944 and spread fairly rapidly until quarantine measures were introduced, but results were not serious. In addition, during the same year, Epivaginitis in cows and Epididymitis in bulls appeared in high-grade stock.

African Coast Fever, Theileriosis, Piroplasmosis and Anaplasmosis all continued to occur in insignificant outbreaks and were attributed to the difficulties of maintaining complete dipping control measures.

The Chief Veterinary Surgeon stresses the necessity for the control and, if possible, the eradication of the dairy cattle diseases, such as Contagious Abortion, Tuberculosis, Mastitis, Epivaginitis and Sterility. He advocates the immediate commencement of survey work while the dairy industry is still in its infancy and before these already existing diseases become a major problem.

An appendix to each report shows statistics for the annual export of meat and prepared meat products from the colony's commercial factories. In addition to the United Kingdom, the surrounding African territories all received large quantities. (Approximately 14,000,000 lb. were exported in 1946.)

No mention is made of the export of dairy or hide products.

The Countryman at Work. By THOMAS HENNELL, with a Memoir by H. J. MASSINGHAM. London: The Architectural Press, 1947. Price: 12s. 6d.

THOMAS HENNELL had established himself as one of the coming, if not already arrived, young British artists, when, alas! he was killed by terrorists in Java in October, 1945. He was a son of the manse, and a pretty eccentric one at that, but he was also a child of the soil and never so happy as when he was wandering about the countryside drawing and painting. "The Countryman at Work" is in a sense a memorial volume. It comprises articles describing country crafts and craftsmen which he published in the *Architectural Review* in the war years of 1941 and 1943. They form a valuable and interesting documentary record and are illuminated by numerous drawings which display Hennell's gift of acute observation. Mr. H. J. Massingham contributes a long memoir of his friend, from which it is easy to see how close the two men stood to one another and how highly Hennell's friendship was valued. A good book, and one for every man who loves to see and understand the craftsmanship of the English countryside which is so fast disappearing.

NOTES AND NEWS

FOWL-PEST*

THE fowl pest position has deteriorated recently, and more outbreaks are being confirmed now than at any previous time. This is happening in spite of the measures taken to control the spread of infection. Much of the trouble now

* Ministry of Agriculture News Service, No. 425, November, 1947.

occurring is due to the operations of dealers and the movement of birds from affected localities in England to other parts of the country.

To check the spread of infection, an Order—The Live Poultry (Regulation of Sales, Exhibitions and Movements) Order of 1947—has been made and is now in force. Within the more heavily infected part of Great Britain—and this extends over much of the southern, eastern and midland counties of England—sweeping restrictions have been imposed on the sale, exhibition and movement of live poultry, and the collecting of poultry by dealers. In addition, movement of birds out of the area is prohibited, and a ban has been placed on the movement of poultry into Scotland, which has, up to now, remained free from the disease.

As day-old chicks are not likely to be responsible for the spread of the disease, the Order does not apply to them. Every poultry keeper and everyone concerned in the trade in live poultry should make himself familiar with the terms of the Order. Copies can be got from the Ministry of Agriculture and Fisheries, 99, Gresham Street, London, E.C.2.

It is even more important that the poultry keeper should be aware of the symptoms of the disease that he should look for. An unusual number of deaths in the flock, unaccompanied by other signs of disease, should be enough to rouse his suspicions. Other symptoms of fowl pest are that birds become dejected and listless and they refuse food. They may have a high temperature and feathers are ruffled. Breathing may be rapid or gasping and accompanied by gurgling or rattling sounds. Gaping with the beak is often seen, and diarrhœa of a greenish-yellow colour. Nervous twitching of the head and neck and partial paralysis of the wings and legs may occur and there may be a discharge from the eyes and nostrils. Egg production falls rapidly.

The death rate is very variable and so, too, are the signs of disease in individual cases. Some birds may show all or most of the symptoms described, others only one or two. In some outbreaks the symptoms are of a catarrhal character, while in others there are symptoms of nervous disorder. The poultry keeper should bear in mind that it is of the first importance to report to the police immediately if he suspects that any of his birds are affected.

There are two safeguards against infection which everyone who keeps poultry must, for his own protection, take. First, do not buy poultry from a dealer. Dealers have been responsible in recent months for most of the spread of infection. Second, see that no unboiled waste foodstuff—which may contain poultry waste—comes within the reach of the birds. This commonsense precaution is one the poultry keeper is now compelled by law to take. Compliance with the law should not be perfunctory. It is most important to take care in sterilising the material. It is no use boiling foodstuffs—and they must be boiled thoroughly—and then put them in dirty containers, which may already be infected, or add to the boiled material other foodstuffs that may be infected.

MILK (Special Designations) REGULATIONS 1936-1946

Tuberculin Testing of Animals by Private Veterinary Surgeons.

THE Minister of Health has modified the directions given by him in paragraph 33 of Circular 1533, dated April 24, 1936, to the extent that the manner of carrying

out the tuberculin test of an animal by a private veterinary surgeon for the purposes of the above-mentioned regulations, may be either in accordance with the double intradermal test or in accordance with a single intradermal comparative test. Where the latter test is applied, the form of certificate of tuberculin test shall be as set out in Appendix I to Memorandum 197/Foods (January, 1937), with any necessary adaptations.

Details of the new tests, etc., will be supplied to persons concerned on application to the Ministry of Health, Whitehall, S.W.1. (Reference VD 93442/1/20.)

The following is a copy of the circular letter describing the modified directions which the Ministry has sent to County and County Borough Councils.

Ministry of Health,
Whitehall, S.W.1.
October 28, 1947.

Milk (Special Designations) Regulations, 1936-1946: *Modification of the Minister's directions regarding the manner of carrying out and of certifying the tuberculin test of animals.*

(1) I am directed by the Minister of Health to say that he has been informed by the Minister of Agriculture and Fisheries that a tuberculin test experiment completed in 1946, covering nearly 10,000 cattle, has shown a close comparison between the results yielded by the single intradermal test and the double intradermal test. The Agricultural Research Council have considered the results of the experiment and are satisfied that on the scientific evidence before them the single test proved as effective as the double.

(2) The single intradermal comparative test, as described in the attached schedule, has been adopted by the Minister of Agriculture and Fisheries for all official tests of attested herds and, with the concurrence of the Minister of Health, is accepted by him for all tests by veterinary inspectors of herds licensed for the production of Tuberculin Tested milk.

(3) The Minister of Health has decided that, where tuberculin testing of herds for the purpose of the Milk (Special Designations) Regulations, 1936-1946, is carried out by private veterinary surgeons, licensing authorities should be able to accept this test. In pursuance, therefore, of the powers in that behalf conferred on him by the Milk (Special Designations) Order, 1936, as amended by the Milk (Special Designations) Amendment Order, 1938, the Minister hereby modifies the directions given by him in paragraph 33 of Circular 1533 of the 24th April, 1936, to the extent

(i) that the manner of carrying out the tuberculin test of an animal shall be either in accordance with the double intradermal method as described in sub-paragraph (b) of the said paragraph 33, or in accordance with the single intradermal comparative test, as described in the attached schedule, and

(ii) that, in cases where the latter test is applied, the form of certificate of tuberculin test shall be as set out in Appendix I to Memorandum 197/Foods, with the substitution of the words "single intradermal comparative" for the words "double intradermal," and of columns giving

observations at the 72nd hour after the injection for the columns provided for observations at the 48th hour after the first injection and the 24th hour after the second injection.

The said directions shall accordingly have effect as modified hereby until they are revoked or further modified.

(4) A copy of this Circular Letter has been sent to the Medical Officer of Health and further copies may be obtained from the Ministry of Health, Whitehall, London, S.W.1.

I am, Sir,
Your obedient Servant,
P. N. R. BUTCHER,
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or
The Clerk of the Council.

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For further information, please write to Veterinary Section.

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ANNOUNCEMENT

The following Trade Marks have been assigned as of date the 30th March, 1946, by British Cod Liver Oil Producers (Hull) Limited (now The Hull Cod Liver Oils Limited), of Hull, to British Cod Liver Oils (Hull & Grimsby) Limited, of St. Andrew's Dock, Hull, without the goodwill of the business in which they were then in use:—

Mark: ULLVITAX; No. 559151; Goods registered: Fish oils and by-products thereof prepared for use in medicine and pharmacy. ALLVITAX; No. 559152: Fish oils and by-products thereof prepared for use in medicine and pharmacy. SOLVITAX; No. 559153: Fish oils and by-products thereof prepared for internal use in medicine and pharmacy. Trawler device; No. 560742: Preparations of cod liver oil for veterinary purposes. Trawler device; No. 560743: Preparations of cod liver oil for use in medicine and pharmacy. Trawler device; No. 563820: Preparations of cod liver oil for use as food. SOLVITAX; No. 565223: Fish oils and by-products thereof prepared for veterinary purposes. SOLVITAX; No. 565224: Fish oils and by-products thereof all for use as food or as ingredients in food. SOLVITAX and Trawler device; No. 567753: Preparations of cod liver oil for veterinary purposes. SOLVITAX and Trawler device; No. 567754: Preparations of cod liver oil for use in medicine and pharmacy. SOLVITAX and Trawler device; No. 567755: Preparations of cod liver oil being foodstuffs. SEVENSEAS; No. 575062: Fish oils and by-products thereof prepared for use in medicine and pharmacy. SEVENSEAS; No. 575889: Fish oils and by-products thereof prepared for veterinary purposes. SEVENSEAS; No. 575890: Fish oils and by-products thereof all for use as food or as ingredients in food. SOLVITAX; No. 630695: Vegetable oils and vegetable fats, all for food.

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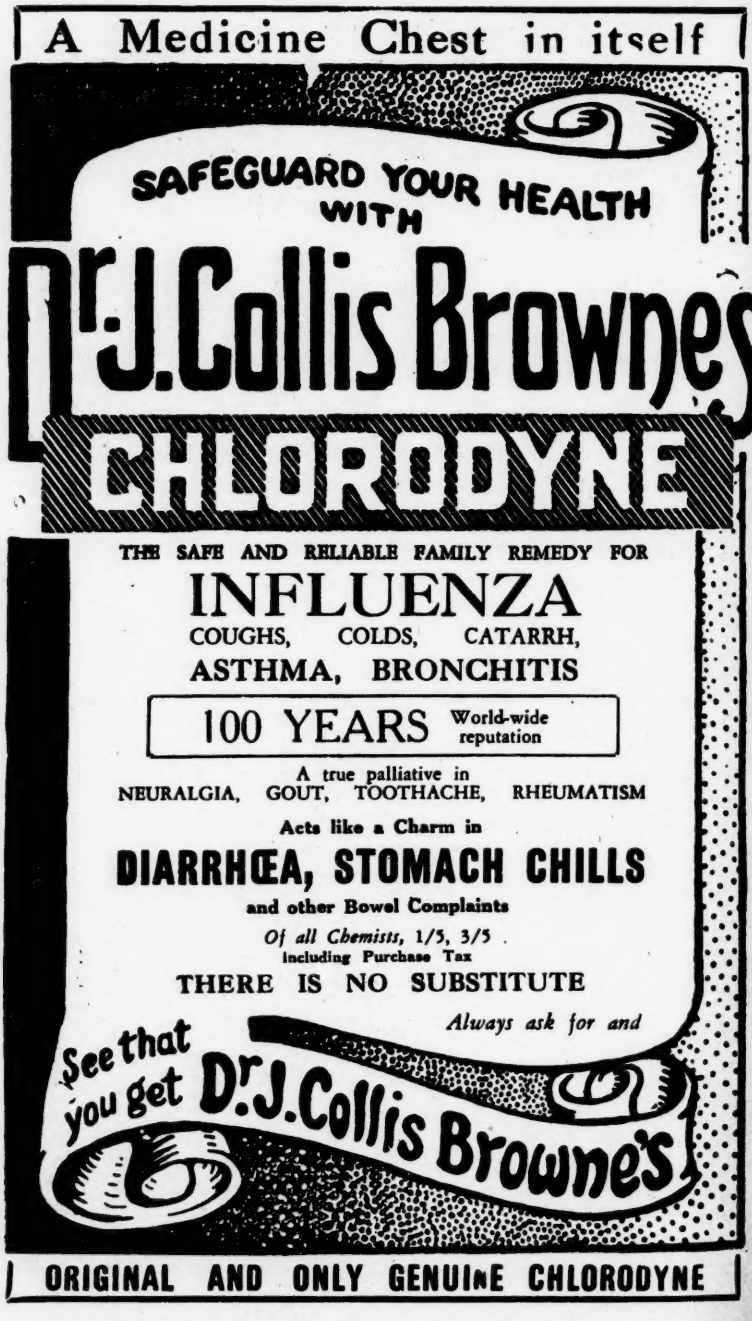
VC1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